

PATENT COOPERATION TREATY

PCT

REC'D 12 MAY 2004

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY PCT (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P00118		FOR FURTHER ACTION See Form PCT/IPEA/416																									
International application No. PCT/SE 2003/000238	International filing date (day/month/year) 13.02.2003	Priority date (day/month/year) 25.02.2002																									
International Patent Classification (IPC) or national classification and IPC G03F 7/20																											
Applicant Micronic Laser Systems AB et al																											
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>7</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (sent to the applicant and to the International Bureau) a total of <u>10</u> sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>																											
<p>4. This report contains indications relating to the following items:</p> <table> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. I</td> <td>Basis of the report</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability, citations and explanations supporting such statement</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table>				<input checked="" type="checkbox"/>	Box No. I	Basis of the report	<input type="checkbox"/>	Box No. II	Priority	<input type="checkbox"/>	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	<input checked="" type="checkbox"/>	Box No. IV	Lack of unity of invention	<input checked="" type="checkbox"/>	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability, citations and explanations supporting such statement	<input type="checkbox"/>	Box No. VI	Certain documents cited	<input checked="" type="checkbox"/>	Box No. VII	Certain defects in the international application	<input type="checkbox"/>	Box No. VIII	Certain observations on the international application
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Date of submission of the demand 25.09.2003		Date of completion of this report 04.05.2004																									
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE 2003/000238

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

- ☐ This report is based on a translation from the original language into the following language _____, which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

- ☐ the international application as originally filed/furnished
- ☒ the description:
- pages 1-25 as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☒ the claims:
- pages _____ as originally filed/furnished
- pages* _____ as amended (together with any statement) under Article 19
- pages* 26-35 received by this Authority on 27-02-2004
- pages* _____ received by this Authority on _____
- ☒ the drawings:
- pages 1-8 as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

Box No. IV Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
☒ paid additional fees.
☐ paid additional fees under protest.
☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

- ☐ complied with.
☐ not complied with for the following reasons:

4. Consequently, this report has been established in respect of the following parts of the international application:

- ☒ all parts.
☐ the parts relating to claims Nos. _____

Box No. V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-59</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-59</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-59</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Since the application comprises two inventions, this report contains two views on patentability, one on each group of claims.

Claims 1-39, 58-59**The first invention**

The present invention concerns patterning a work piece covered with a layer sensitive to electromagnetic radiation, using a source emitting electromagnetic radiation and an SLM.

A problem with pulsed electromagnetic radiation sources is that they may have a pulse to pulse energy variation or a variation in time between adjacent pulses.

The problem is overcome by synchronising the motion of the work piece relative to a relayed pattern description from the SLM onto said work piece. Furthermore, there is an image-deflecting element arranged between the SLM and the work piece.

Cited documents according to the first search

The following documents are cited in the International Search Report. The citations are considered to describe the most relevant prior art:

D1) US, 6 312 134 B1

D2) JP, 6 095 257 A

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: BOX V

A lithography system is already known from D1 (fig. 1 & column 7, lines 8-23). The system is built up of a radiation source (1), a spatial light modulator, shown in FIG. 1 as a deformable micromirror device (DMD) (3), and a substrate (5). The micromirrors tilt in different directions for selective reflection or deflection of individual pixels. In order to ensure that the pattern imaged onto the substrate is not blurred, the pixel selection data stream configuring the DMD array (3) must be synchronized with the motion of the scanning stage (6) (column 7, lines 30-34).

D2 discloses similar technique to that of D1.

Analysis of the first invention

D1 and D2 are cited in the International Search Report as documents of particular relevance and are now considered to show the closest background art. The reason for this review is that amended and independent claims 1, 18, 37, 58 and 59 of February 27, 2004, now specify that at least two pattern descriptions on said SLM are at least partly overlapping on the work piece.

These features are not revealed in D1 or D2. Consequently, neither D1 nor D2 anticipates the technique of claims 1, 18, 37, 58 and 59.

The apparatuses and methods for patterning a work piece and the work piece according to amended claims 1, 18, 37, 58 and 59 are considered to give rise to an unexpected technical effect, i.e. providing a work piece with high resolution. Thus, these claims are not considered to describe a technique that is obvious to a person skilled in the art.

Claims 1-39, 58-59**Cited documents according to the second search**

D1) WO, 0118606 A1

D2) US, 6 060 224 A

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: BOX V

D3) US, 2002021426 A1

D4) US, 6 285 488 B1

The cited documents represent the general state of the art.
The invention defined in claims 40-57 is not disclosed by any of these documents.

The cited prior art does not give any indication that would lead a person skilled in the art to the claimed methods and apparatus to form an image by modulating a beam and creating a coherent sub-image on a work piece and sub-images that are non-coherently superimposed. Therefore, the claimed invention is not obvious to a person skilled in the art.

Accordingly, the invention defined in claims 40-57 is novel and is considered to involve an inventive step. The invention is industrially applicable.

Conclusion of all claims 1-59, i. e. both inventions

In accordance with the arguments stated above, the invention in claims 1-59 is novel, considered to involve an inventive step and has industrial applicability.

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

Claims

Claims shall contain: a characterising portion — preceded by the words "characterised in that," "characterised by," or any other words to the same effect (Rule 6.3 (b)).

Where the international application contains drawings, the technical features mentioned in the claims shall preferably be followed by the reference signs relating to such features. See Rule 6.2 (b).

In claim 58, the term SLM is preceded by the word "said", although the SLM has not been mentioned earlier in the claim.

Description

The technical feature (620) in fig. 6 is not described in the description.

CLAIMS

1. An apparatus for patterning a work piece arranged at an image plane and covered at least partly with a layer
5 sensitive to electromagnetic radiation, comprising
- a source emitting electromagnetic radiation onto an object plane,
 - an SLM comprising a plurality of on-off object pixels, adapted to receive and modulating said electromagnetic
10 radiation at said object plane in accordance to an input pattern description and to relay said electromagnetic radiation toward said work piece,
 - a synchroniser to synchronise the motion of the work piece relative to a relayed pattern description from said SLM onto
15 said workpiece, and
 - an image-deflecting element arranged between said SLM and said workpiece adapted to deflect said relayed pattern description, wherein at least two pattern descriptions on said SLM are at least partly overlapping on the workpiece.
- 20
2. The apparatus according to claim 1, wherein said SLM comprises transmissive pixels.
3. The apparatus according to claim 1, wherein said SLM
25 comprises reflective pixels.
4. The apparatus according to claim 3, wherein said reflective pixels are micromirrors.
- 30
5. The apparatus according to claim 1, wherein said synchronisation is performed to cause said relayed pattern description to impinge on a fixed area of said workpiece for an extended period of time.

6. The apparatus according to claim 1, wherein radiation from said electromagnetic radiation source is prevented from impinging onto said workpiece while reloading said SLM with a new pattern description.

5

7. The apparatus according to claim 6, wherein said radiation is deflected in order to be prevented from impinging onto said workpiece.

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8. The apparatus according to claim 6, wherein said radiation is blocked in order to be prevented from impinging onto said workpiece.

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9. The apparatus according to claim 6, wherein said radiation source is switched off in order to prevent said radiation from impinging onto said workpiece.

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10. The apparatus according to claim 1, wherein successive pattern descriptions on said SLM are imaged onto said workpiece adjacent to each other.

25

11. The apparatus according to claim 1, wherein the modulation crates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create a final image.

30

12. The apparatus according to claim 10, wherein successive pattern descriptions on said SLM are non-overlapping on said workpiece.

13. The apparatus according to claim 1, wherein successive pattern descriptions on said SLM are imaged onto said workpiece non-adjacent to each other.

14. The apparatus according to claim 1, wherein said image deflecting element is a rotating prism.

5 15. The apparatus according to claim 1, wherein said image deflecting element is a rotating reflective polygon.

16. The apparatus according to claim 15, wherein said rotating reflective polygon comprises at least three reflecting surfaces.

10 17. The apparatus according to claim 1, wherein said pattern description on said SLM is changed while deflecting said relayed pattern description onto the workpiece.

15 18. A method for patterning a work piece arranged at an image plane and covered at least partly with a layer sensitive to electromagnetic radiation, comprising the actions of:

- emitting electromagnetic radiation onto an object plane,
- 20 - receiving and modulating said electromagnetic radiation at said object plane in accordance to an input pattern description by an SLM comprising a plurality of on-off object pixels,
- relaying said electromagnetic radiation toward said work
- 25 piece,
- deflecting a relayed pattern description from said SLM onto said workpiece,
- synchronising the motion of the work piece relative to said relayed pattern description from said SLM onto said
- 30 workpiece, wherein at least two pattern descriptions on said SLM are at least partly overlapping on the workpiece.

19. The method according to claim 18, wherein said SLM comprises transmissive pixels.

20. The method according to claim 18, wherein said SLM comprises reflective pixels.

5 21. The method according to claim 20, wherein said reflective pixels are micromirrors.

10 22. The method according to claim 18, wherein said synchronising is performed to cause said relayed pattern description from said SLM to impinge on a fixed area of said workpiece for an extended period of time.

23. The method according to claim 18, further comprising the action of

15 - preventing said radiation from said electromagnetic radiation source from impinging onto said workpiece while reloading said SLM with a new pattern description.

20 24. The method according to claim 23, wherein said radiation is deflected in order to be prevented from impinging onto said workpiece.

25 25. The method according to claim 23, wherein said radiation is blocked in order to be prevented from impinging onto said workpiece.

30 26. The method according to claim 23, wherein said radiation source is switched off in order to prevent said radiation from impinging onto said workpiece.

27. The method according to claim 18, further comprising the action of:

- imaging successive pattern descriptions onto said workpiece adjacent to each other.

28. The method according to claim 27, where the modulation creates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create a final image..

5

29. The method according to claim 27, wherein successive pattern descriptions are non-overlapping on said workpiece.

10

30. The method according to claim 18, further comprising the action of:

- imaging successive pattern descriptions onto said workpiece non-adjacent to each other.

15

31. The method according to claim 18, wherein said image deflecting element is a rotating prism.

32. The method according to claim 18 wherein said image deflecting element is a rotating reflective polygon.

20

33. The method according to claim 32, wherein said rotating reflective polygon comprises at least three reflecting surfaces.

25

34. The method according to claim 18, further comprising the action of:

- performing greyscale printing by time multiplexing the object pixels.

30

35. The method according to claim 18, wherein said synchronisation is performed to write stamps onto said workpiece corresponding to pattern descriptions on said SLM, where said stamps defining sub-images together form a complete pattern.

35

36. The method according to claim 18, further comprising the action of:

- changing said pattern description on said SLM while deflecting said relayed pattern description onto the workpiece.

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37. A work piece arranged at an image plane and covered with a layer sensitive to electromagnetic radiation, wherein said layer is illuminated by electromagnetic radiation relayed from an SLM, arranged at an object plane and comprising a plurality of on-off object pixels, adapted to receive and modulating said electromagnetic radiation at said object plane in accordance to an input pattern description, a motion of said workpiece is synchronised with said relayed pattern description from said computer-controlled reticle onto said workpiece, said relayed pattern description is deflected by an image deflecting element arranged between said SLM and said workpiece, wherein at least two pattern descriptions on said SLM are at least partly overlapping on the workpiece.

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38. The workpiece according to claim 37, wherein said workpiece is a reticle or a mask.

39. The workpiece according to claim 37, wherein said workpiece is a semi-conducting wafer.

25

40. A method to form an image comprising the actions of:

- providing a laser source,
- scanning at least one beam from said laser source over a workpiece,
- modulating said at least one beam during scanning according to an input pattern data file, where said modulation of the beam creates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create a final image.

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41. The method according to claim 40, further comprising the action of:

- destroying the interference between individual beams before
5 impinging onto the SLM.

42. The method according to claim 41, wherein said interference between individual beams are destroyed by means of adding or subtracting a shift in frequency.

10 43. The method according to claim 41, wherein said interference between individual beams are destroyed by means of adding or subtracting a portion of path length.

15 44. The method according to claim 40, wherein said at least one beam is modulated by means of an acoustooptic cell comprising an array of transducers.

20 45. The method according to claim 40, wherein said transducers are driven by a RF wave multiplied by an analogue signal.

46. The method according to claim 40, wherein said at least one beam is modulated by means of an SLM comprising a plurality of on-off pixels.

25 47. A method for forming an image onto a workpiece, comprising the actions of:

- providing an electromagnetic radiation source,
- scanning at least one beam from said source over at least a
30 portion of a spatial light modulator,
- modulating said at least one beam according to an input pattern data file, where said modulation of the at least one beam creates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create
35 a final image.

48. The method according to claim 47, further comprising the action of:

- reloading a new pattern description on at least one portion of said modulator while scanning a different portion of said modulator by said at least one beam.

49. The method according to claim 47, wherein said SLM comprising a plurality of on-off pixels.

50. An apparatus for forming a pattern on a radiation sensitive material comprising:

- a source to form a radiation beam,
- a scanning element to scan at least one beam from said radiation source over said radiation sensitive material,
- a modulator to modulate said at least one beam during scanning according to an input pattern data file, where said modulation of the beam creates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create a final image.

51. The apparatus according to claim 50, further comprising an element to destroy the interference between individual beams before impinging onto the SLM.

52. The apparatus according to claim 51, wherein the interference is destroyed by an element, which adds or subtracts a shift in frequency unequal for interferable beams.

53. The apparatus according to claim 51, wherein the interference is destroyed by an element, which adds or subtracts a unequal portion of optical path-length for interferable beams.

54. The apparatus according to claim 51, wherein said modulator is an acoustooptic cell comprising an array of transducers.

55. The apparatus according to claim 54, wherein said transducers are driven by a RF wave multiplied by an analogue signal.

56. An apparatus for forming a pattern on a radiation sensitive material comprising:

- a source to form a radiation beam,
- a scanning element to scan at least one beam from said radiation source over a spatial light modulator,
- a modulator to modulate said at least one beam according to an input pattern data file, where said modulation of the beam creates a coherent sub-image on the workpiece and several sub-images are non-coherently superposed to create a final image.

57. The apparatus according to claim 56, where a new pattern description is reloaded on at least one portion of said modulator while scanning a different portion of said modulator by said at least one beam.

58. An apparatus for patterning a work piece arranged at an image plane and covered at least partly with a layer sensitive to electromagnetic radiation, comprising

- a source emitting electromagnetic radiation onto an object plane,
- a modulator comprising a plurality of modulating elements, adapted to receive and modulating said electromagnetic radiation at said object plane in accordance to an input pattern description and to relay said electromagnetic radiation toward said work piece,

- a synchroniser to synchronise the motion of the work piece relative to a relayed pattern description from said SLM onto said workpiece and a loading of said input pattern description, and
 - 5 - an image-deflecting element adapted to deflect said relayed pattern description on the workpiece, wherein at least two pattern descriptions on said SLM are at least partly overlapping on the workpiece.
- 10 59. A method for patterning a work piece arranged at an image plane and covered at least partly with a layer sensitive to electromagnetic radiation, comprising the actions of:
- emitting electromagnetic radiation onto an object plane,
 - receiving and modulating said electromagnetic radiation at
15 said object plane in accordance to an input pattern description by a modulator comprising a plurality of modulating elements,
 - relaying said electromagnetic radiation toward said work piece,
 - 20 - deflecting a relayed pattern description from said modulator onto said workpiece,
 - synchronising the motion of the work piece relative to a relayed pattern description from said modulator onto said workpiece and a loading of said input pattern description,
25 wherein at least two pattern descriptions on said SLM are at least partly overlapping on the workpiece.